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COSTS OF FILTER PRESSING DOMESTIC SEWAGE SLUDGES

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COSTS OF FILTER PRESSING
DOMESTIC SEWAGE SLUDGES

by

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FOREWORD

Man and his environment must be protected from the adverse effects of pesticides, radiation, noise and other forms of pollution, and the unwise management of solid waste. Efforts to protect the environment require a focus that recognizes the interplay between the components of our physical environment--air, water, and land. The National Environmental Research Centers provide this multidisciplinary focus through programs engaged in

- studies on the effects of environmental contaminants on man and the biosphere, and
- a search for ways to prevent contamination and to recycle valuable resources.

This report presents costs associated with one process that may be used to dewater sewage sludge.

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ABSTRACT

Estimates of capital and operating costs and operating and maintenance labor man hours, associated with filter pressing of two types of sludge are presented.

COSTS OF FILTER PRESSING

Although filter pressing has been employed for many years as an industrial process, only recently has it been considered as a method of dewatering domestic sewage sludges in the United States. A number of facilities are in the design and construction stages, but Cedar Rapids (Iowa) is the only major municipal sewage treatment plant in the United States now employing this process. Therefore, very little experienced cost or performance information is available. Consequently, this report is based almost entirely on information obtained from manufacturers of filter pressing equipment.

Although others are striving to enter the market, presently, only two companies are actively engaged in providing filter pressing systems for municipal sewage treatment plants in this country. Each advocates a system distinctly different from the other: one recommends the use of an inert material, such as fly ash or incinerator ash, for filter precoating and lime and ferric chloride along with ash for sludge conditioning; the other does not employ precoating and recommends only lime and ferric chloride for sludge conditioning.

The size or capacity of filter pressing equipment required for a given sludge production rate is affected by the ease with which a sludge can be dewatered, and this depends, in part, on the type of sludge. This report presents the costs associated with filter pressing two typical sludges: (a) digested, mixed, primary and waste activated and (b) raw primary.

Costs for both of these sludges are presented in two ways. In one, the capital costs and operating and maintenance costs are shown as functions of the design capacity of the sewage treatment plant (Figures 1 and 2). This method is appropriate when filter pressing is considered as a process apart from the other processes in the treatment plant. In the other, construction costs, man hour requirements, and material and supply costs are presented as functions of appropriate process sizing parameters (Figures 3-6). With this approach, these costs can be added to the costs of such other unit processes as have been described elsewhere (1), (2).

Like vacuum filtration, filter pressing is a process that may be operated only part time. Part-time operation is more prevalent at small plants than at larger installations. An operating schedule must be determined before the size of equipment for a given installation may be determined. The commonly observed operating schedules for filter presses in the different sized wastewater treatment plants used in this cost estimate are:

Up to 2 mgd	40 hours per week
2 to 5 mgd	80 hours per week
5 to 20 mgd	100 hours per week
Over 20 mgd	168 hours per week

Pressing time, which depends on the type of sludge to be dewatered, must also be known or assumed before the size of the equipment may be determined. Because very few domestic sewage treatment plants use filter pressing, it is not possible to generalize, but comparison of filter press installations, at two cities

permits some tentative conclusions regarding the effect of ash on cycle time. The Cedar Rapids, Iowa, (3) sewage treatment plant has an average daily flow of about 29 mgd ($190,765 \text{ m}^3/\text{day}$). Digested sludge is dewatered in a filter pressing facility. Ash is used as a filter aid, and the design cycle time is 2 hours. For comparison, the City of Kenosha, Wisconsin, has a 16-mgd ($60,560 \text{ m}^3/\text{day}$) sewage treatment plant at which a filter pressing facility, using another manufacturer's equipment, is presently under construction. This facility will not use ash but will condition the digested sludge with lime and ferric chloride. The design cycle time will be about 4 hours.

This difference in cycle time would significantly affect the press volume required for a given installation were it not for the increase in sludge volume caused by adding ash. At Cedar Rapids, the process is designed to operate with an ash to sludge ratio of 1.5 thus giving a weight of solids filtered equal to 2.5 times the weight of sludge solids. Design criteria for these two installations also indicate that, with the addition of ash, the filter cake will be somewhat denser and drier. The shorter cycle time tends to offset the greater weight of solids to be filtered with respect to required press capacity. The results is that, for conceptual cost estimates, and with the types of sludge considered here, the press volume required, for a given installation, may be considered to be the same whether or not ash is used for sludge conditioning and precoating. The costs presented here may, therefore, be considered applicable for either of the systems advocated by these two manufacturers

even though the sludges at Cedar Rapids and Kenosha differ from the two types considered here.

The capacity of a filter press is determined by the size of the individual trays and the number of trays in the press. Trays are available in thicknesses ranging from less than 1 inch to over 2 inches. Choice of thickness is determined by the type of sludge to be dewatered; more easily dewatered sludges may be pressed in thicker cakes. For the purpose of this estimate, a cake thickness of 1 inch was chosen for the digested sludge and $1\frac{1}{4}$ inches for the raw sludge. These are believed to be conservative.

Flexibility must be provided in the operating schedule to allow time for maintenance and repair work. This is automatically taken care of in smaller plants where the pressing system is normally operated only part time. In plants of over 20 mgd capacity that operate about 168 hours per week, flexibility is provided by the use of multiple filter presses. This cost estimate does not provide for any idle presses in plants operating 24 hours per day; however, an allowance is included for extra or standby press feed pumps.

After operating schedules and cycle times have been decided, the press capacity and cost may be determined. The capital and construction costs shown here include the costs of the press(es), associated feed pumps, sludge conditioning system, lime storage and slurry system, ferric chloride storage and mixing system, and an enclosing structure. It is assumed that the lime and ferric chloride storage facilities would be located outdoors.

Figure 1 and Table 1 present capital cost, operating and maintenance costs, and debt service costs for filter pressing digested,

mixed, primary, and waste activated sludge. Figure 2 and Table 2 show the corresponding costs for raw primary sludge.

The term "capital cost" includes the estimated construction cost plus allowances of 20 percent of construction cost for consulting engineering services, legal, fiscal and administrative costs, and 14 percent of construction costs for a proportionate share of the treatment-plant yardwork.

Operating and maintenance costs are made up of operating and maintenance labor, electric power, maintenance materials, and chemical costs. Operating labor applies to the filter presses and all associated equipment. Maintenance labor applies to the process equipment and the enclosing structure. Chemical costs include the costs of lime and ferric chloride used to condition the sludge. Chemical dose rates depend on the nature of the sludge and for this estimate it was assumed that the dosages of lime and ferric chloride were 15 and 4 percent, respectively, of dry sludge solids for the digested sludge and 10 and 2.5 percent, respectively, for the raw primary sludge. All of these percentages are expressed in terms of 100 percent chemical. It was assumed that plant incinerator ash would be available, at no cost, at those press installations requiring it.

Labor costs were based on an hourly wage rate of \$4.00. An amount equal to 25 percent of the direct labor costs was added to cover indirect and administrative labor costs.

The filter pressing costs and manpower requirements in Figures 3 through 6 are presented in a manner compatible with costs for other processes (1). These figures show costs as functions of process sizing parameters. Figures 3 and 4 are plots of construction



cost versus filter press size and Figures 5 and 6 show operating and maintenance manpower requirements and material and supply costs as functions of the weight of dry solids pressed. "Material and Supplies Cost" includes lime, ferric chloride, electric power, and maintenance materials and parts. The term "Construction Cost" includes all normal elements of construction costs encountered by a contractor. It does not include consulting engineering, legal, fiscal or administrative costs nor any construction work outside the limits of the filter pressing facility.

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Table 1. COSTS OF FILTER PRESSING DIGESTED, MIXED
PRIMARY AND WASTE ACTIVATED SLUDGE (Figure 1)

Design Capacity, mgd [*]	1	10	100
Capital Cost, \$1000	470	600	2130
Amortization, ¢/1000 gal ^{**} (6% - 25 yr)	10	1.3	0.46
Operation and Maintenance Cost ¢/1000 gal	3.9	1.1	0.75
Total Treatment Cost, ¢/1000 gal	14	2.4	1.2

*1 mgd = 3785 m³/day

**1000 gallons = 3.785 m³

Table 2. COSTS OF FILTER PRESSING RAW PRIMARY SLUDGE (Figure 2)

Design Capacity, mgd [*]	1	10	100
Capital Cost, \$1000	440	510	950
Amortization, ¢/1000 gal ^{**}	9.5	1.1	.21
Operation and Maintenance Cost, ¢/1000 gal	4.2	1.0	.58
Total Treatment Cost, ¢/1000 gal	14	2.1	.79

The assumptions used in estimating costs illustrated in Figures 1 through 6 are summarized below:

	SLUDGE TYPE	
	Digested, Mixed, Primary and Waste Activated	Raw Primary
Quantity	900 lb. dry solids/ mg (108g/m ³)	1075 lb dry solids/mg (129 g/m ³)
Cake Thickness	1 inch (25.4 mm)	1½ inch (31.75 mm)
Excess Capacity Factor	None except that provided by operating schedules of less than 168 hours/week	
Lime Dose as CaO	15% of dry sludge solids	10% of dry sludge solids
Ferric Chloride Dose as FeCl ₃	4% of dry sludge solids	2.5% of dry sludge solids
Filter Cake Moisture Content	60-65%	58-62%
Cycle Time	4 hr	2 hr

*1 mgd = 3785 m³/day
 **1000 gallons = 3.785 m³

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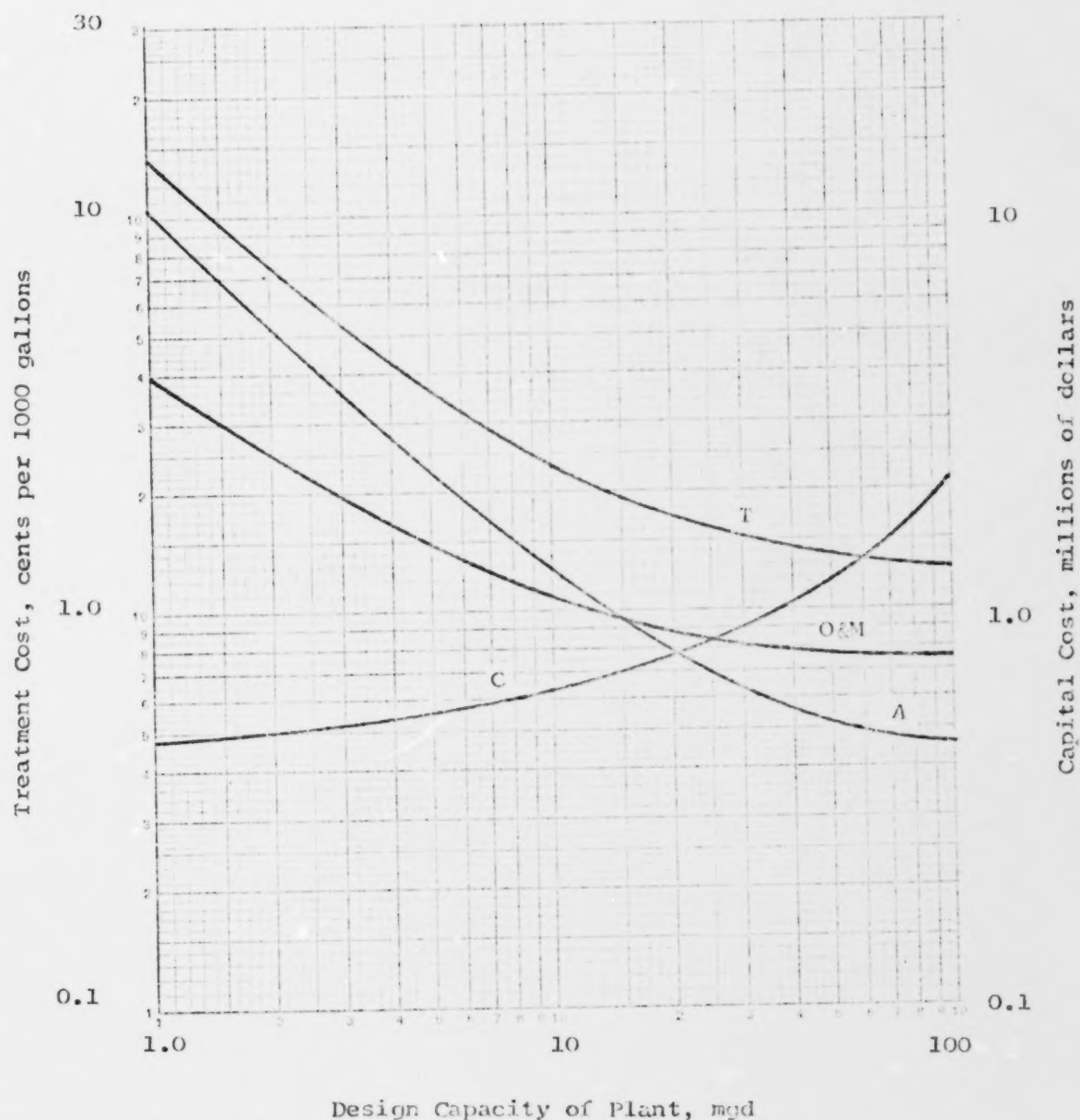


Figure 1

Costs versus design capacity of treatment plant for filter pressing of digested, mixed primary and waste activated sludge.
 C = capital cost, millions of dollars; A = amortization (6% - 25 yr), cents per 1000 gallon; O&M = operating and maintenance cost, cents per 1000 gallon; T = total treatment cost, cents per 1000 gallon

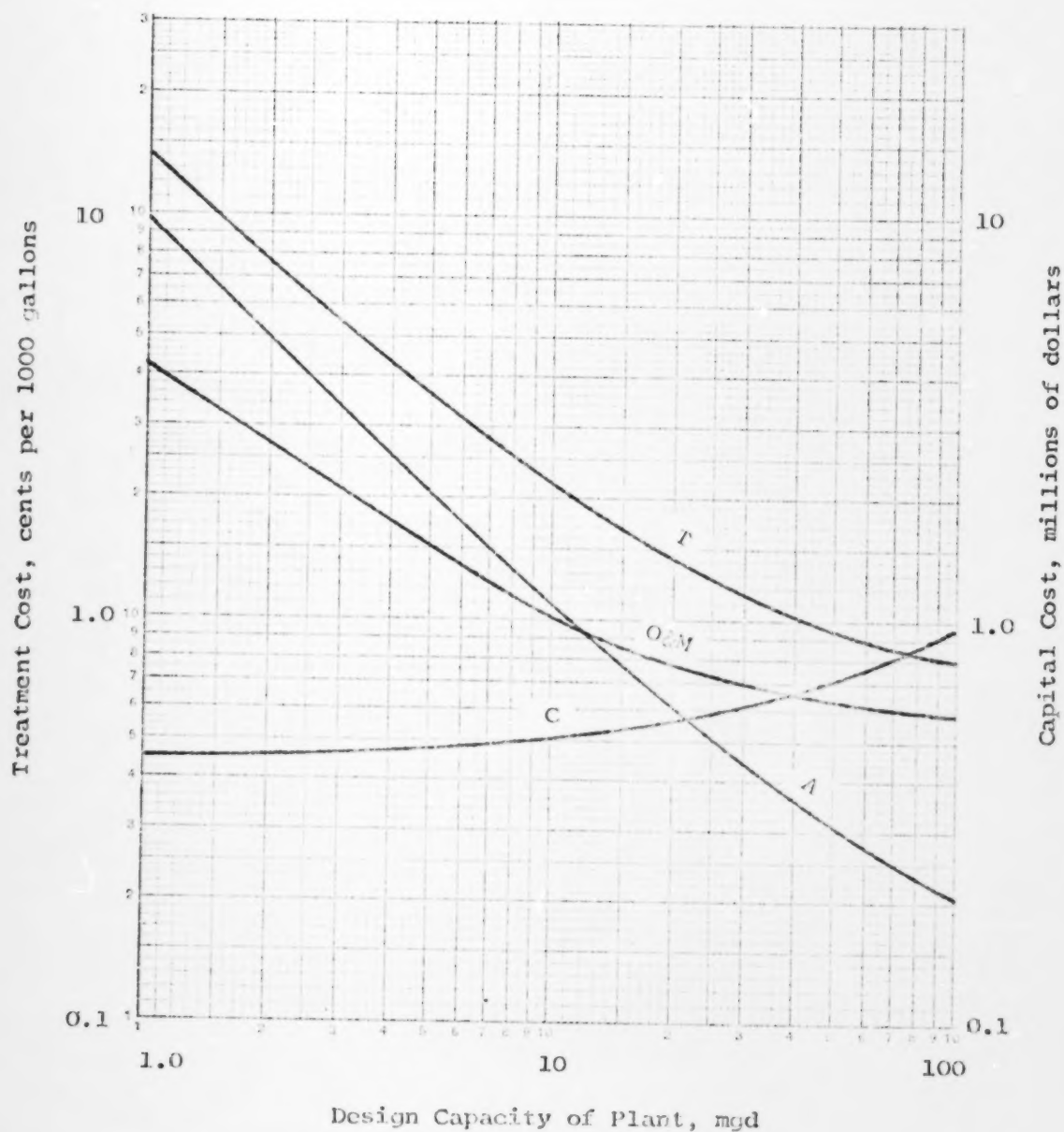


Figure 2

Cost versus design capacity of treatment plant for filter pressing of raw primary sludge. C = capital cost, millions of dollars; A = amortization (6% - 25 yr), cents per 1000 gallons; O&M = operating and maintenance costs, cents per 1000 gallons; T = total treatment cost, cents per 1000 gallons

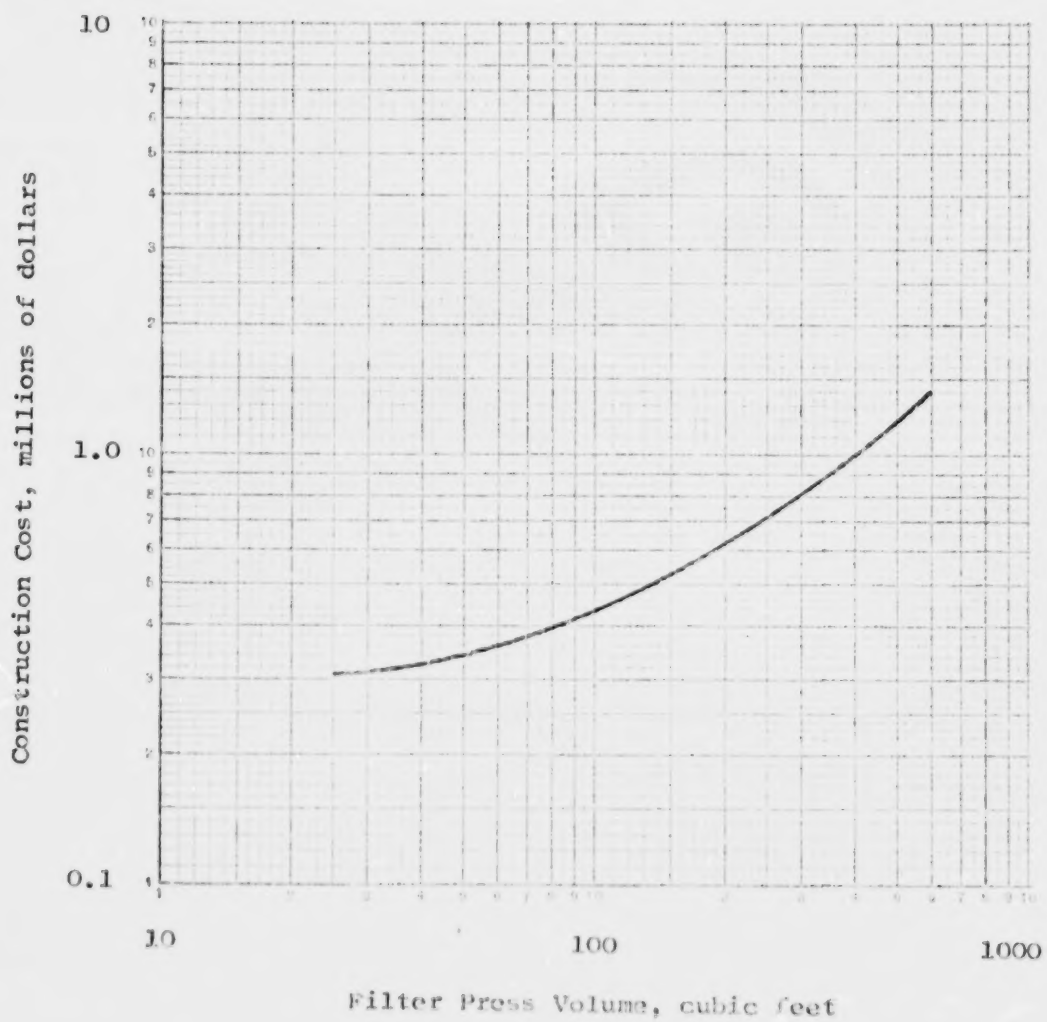
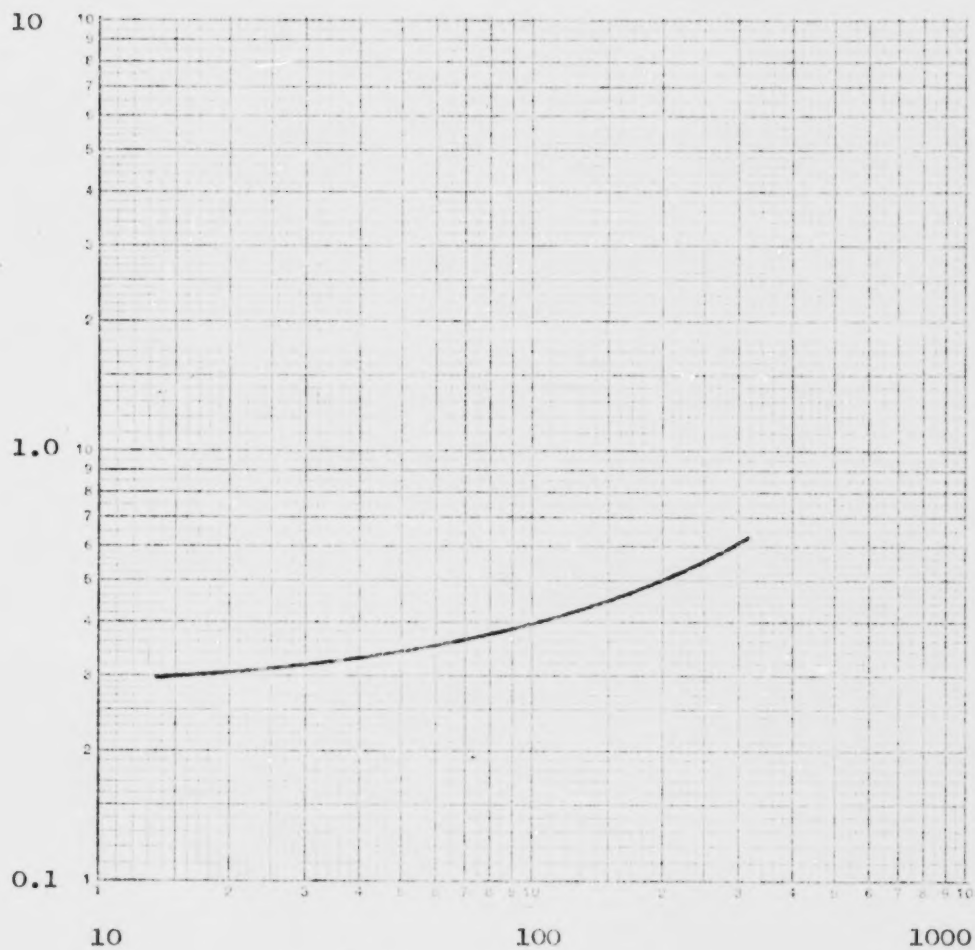


Figure 3
Construction cost versus press volume
(1 inch trays)



Filter Press Volume, cubic feet

Figure 4

Construction cost versus press volume
(1 1/4 inch trays)

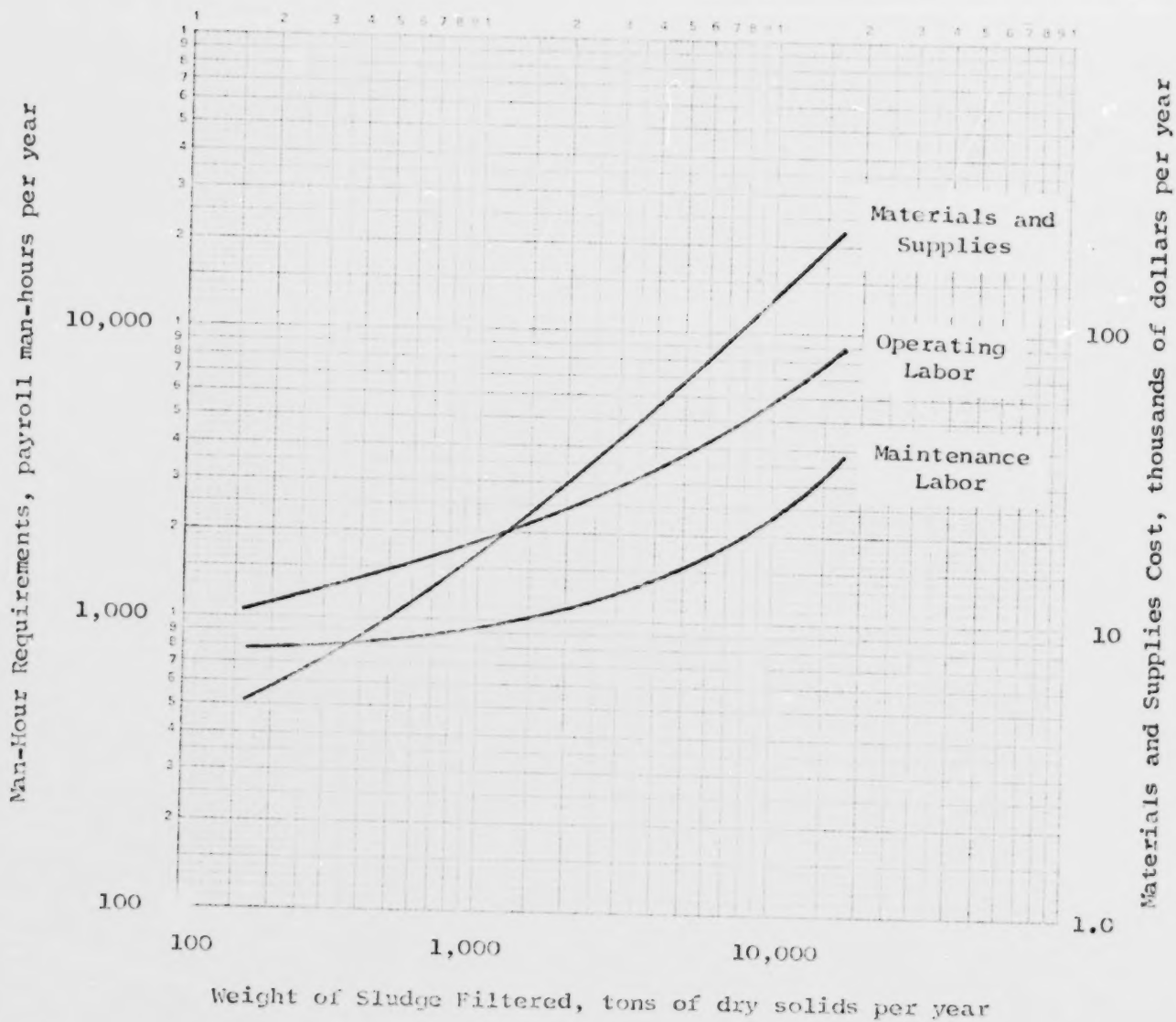


Figure 5

Man-hour requirements and material and supply costs versus weight of digested sludge filtered

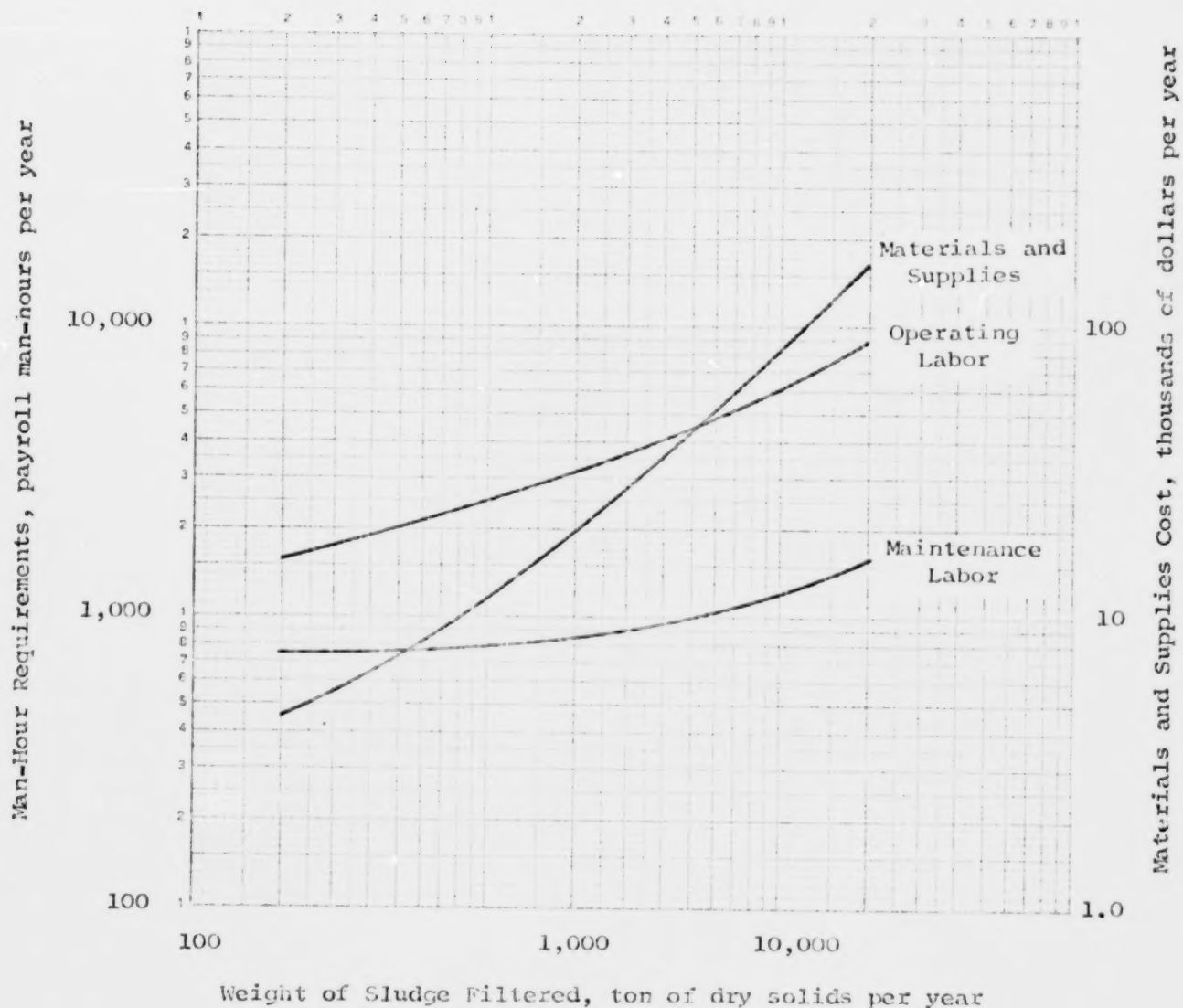


Figure 6

Man-hour requirements and material and supply costs versus weight of raw primary sludge filtered